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## The diecious nature of buffalo-grass\*

JOHN H. SCHAFFNER

The buffalo-grass, *Bulbilis dactyloides* (Nutt.) Raf., was apparently first described by Nuttall in 1818 from a staminate specimen and named *Sesleria dactyloides*. In 1855, Steudel named the carpellate form *Antephora axilliflora* and, in 1859, Engelmann described the buffalo-grass as a diecious plant under the name of *Buchloe dactyloides*.

The species was usually regarded as diecious until in recent years some authors have described it as a peculiar type of monœcious grass. Plank,† in 1892, asserted that the grass was monœcious. He says: "During one of my botanical rambles in Kansas, while walking over soil newly moved by a freshet, I noticed the peculiar appearance of the individual plants of buffalo grass growing upon it. There were scores of them, if not hundreds. All of them appeared to be seedlings, having yet not sent out stolons. All of these plants were monœcious." Plank thought that the stolons proceeding from sexually different parts of the plant each reproduced its own form. And it is true, from what appears below, that any given stolon will produce only staminate or only carpellate inflorescences. The main question is as to the original nature of the seedlings. In 1895, Hitchcock‡ also described a single specimen he had raised from seed as monœcious. He says that a few seeds were germinated in the greenhouse, that a single seedling was transferred to an out door plot, that this plant bloomed in two years, and that both carpellate and staminate flowers were present.

Among the recent manuals the following statements appear: J. K. Small, 1903, *Flora of the Southeastern United States*—"Spikelets dioecious"; N. L. Britton, 1904, *Manual of the Flora of the Northern States and Canada*, second edition—"A perennial

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\* Papers from the Department of Botany, The Ohio State University, No. 114.

† Plank, E. N. *Buchloe dactyloides*, Englm., not a dioecious grass. Bull. Torrey Club 19: 303-306.

‡ Hitchcock, A. S. Note on buffalo grass. Bot. Gaz. 20: 464.

stoloniferous monoecious or apparently dioecious grass"; A. S. Hitchcock in Gray's New Manual of Botany, seventh edition, 1908—"Seedlings are monoecious, but the staminate and pistillate branches propagate their own kind"; J. M. Coulter and A. Nelson, 1909, New Manual of Botany of the Central Rocky Mountains—"Spikelets dioecious (rarely monoecious), very unlike"; Britton and Brown, 1913, An Illustrated Flora of the Northern United States, Canada and the British Possessions, second edition—"A perennial stoloniferous monoecious or apparently dioecious grass."

The writer has been intimately acquainted with buffalo-grass since childhood and had always regarded it as diecious until he read the statements in the recent manuals. Recently the problem of its true nature became of interest because of its possible use in experiments on the nature of sex in the higher plants. It was thought that a plant which began its life by developing both staminate and carpellate branches and then continued these branches with but one type of sexual expression might yield some interesting results when placed under experimental control. But, as will appear below, this expectation was not realized because buffalo-grass is a diecious species under normal conditions, and the writer has not succeeded in his attempt to induce a monoecious character under abnormal conditions, as he has with certain other plants.

#### FIELD OBSERVATIONS

During the summer of 1919, field observations were made at Morganville, Clay County, Kansas. Because of abundant rains in the spring, especially in June, the buffalo-grass bloomed very profusely and the season was unusually favorable for the study. In this region the typical prairie consists largely of *Andropogon scoparius* Michx. and *A. furcatus* Muhl. The buffalo-grass is usually in small sharply defined areas, often forming a nearly pure stand or containing one or more species of *Bouteloua*. On large normal areas there is often a space a yard or more wide which is purely carpellate or purely staminate, but many areas have the staminate and carpellate inflorescences rather closely and uniformly intermingled.

Areas were chosen for study which, in the memory of the writer,

had been cultivated fields, entirely devoid of buffalo-grass, and which had later been abandoned. A ravine filled deep with the wash of surrounding fields was also studied.

1. A small abandoned field much tramped by cattle. There were three small, pure, staminate patches and three small, pure, carpellate patches. No mixed patches were found.

2. An abandoned field, now in pasture, in which patches of buffalo-grass have become established. The patches were as follows:

Carpellate patches		Staminate patches	
No. of patches	Diameter	No. of patches.	Diameter
1	9 ft.	1	8 ft.
1	7 "	1	6 "
1	6 "	1	5 "
3	3 "	2	4 "
		1	3 "

In this field not one case of mingled inflorescences was found. All the patches were pure and were mostly blooming abundantly, some patches being entirely covered with inflorescences. It is probable that each of these patches originated from a single seed.

3. A pasture ravine filled with a deep layer of soil washed from surrounding fields. The new-formed soil was covered with weeds and Kentucky blue-grass and here and there small patches of buffalo-grass had developed. These were mostly over three years old and had probably gained a foothold in this usually rather wet soil because of the very dry seasons of 1917 and 1918. Most of the patches probably developed from seed, although it is possible that detached stolons may have been washed down from hillside patches, or carried in the feet of cattle. Seventeen isolated patches were found in the ravine. There were ten purely carpellate and seven purely staminate. In no case was such a small patch found to have both staminate and carpellate inflorescences.

4. An abandoned field of several acres turned into a pasture, after being sown to tame grasses. Patches of buffalo-grass, some of considerable size, were numerous. They were either of pure stand, staminate or carpellate, or mixed. The mixed patches sometimes had the carpellate and staminate inflorescences commingled, or were staminate in one part and carpellate in another. The patches observed are tabulated below:

Pure carpellate		Pure staminate		Mixed	
No. of patches	Diameter	No. of patches	Diameter	No. of patches	Diameter
1	10 ft.	1	12 ft.	*1	12 ft.
1	8 "	2	10 "	*1	10 "
2	7 "	3	8 "	1	9 "
3	6 "	2	7 "	*1	8 "
3	5 "	3	6 "	1	7 "
1	4 "	2	5 "	*1	6 "
2	3 "	5	4 "	1	4 "
2	2 "	2	3 "	1	2 "
		2	2 "		
3	1 "	1	1 "		
18		23		8	

\* Patches marked with a star had the staminate and carpellate inflorescences in distinct areas.

Of the forty-nine patches found in this field, therefore, forty-one were pure (eighteen carpellate and twenty-three staminate) and only eight were mixed. Of the mixed, four were generally commingled and four had the carpellate and staminate inflorescences in distinct parts of the patch. Presumably the mixed patches originated from more than one seed, although the possibility remains that they represent the vegetative offshoots of a monocious organism.

5. A patch of mixed stand of special interest. One patch was of unusual character and deserves special consideration. It was about 16 ft. long and 6 ft. wide; one end, about 5 ft., was pure staminate; the middle, about 5 ft., was pure carpellate; and the other end, about 6 ft., was pure staminate. On either side of the carpellate patch, where it bordered on the staminate ends, there was a mixed zone of staminate and carpellate inflorescences about a foot wide. This patch has evidently originated from three separate patches side by side, which have but recently been united by vegetative expansion.

#### EXPERIMENTAL RESULTS

Previous to the field observations taken the past summer, as stated above, seed was collected by the writer during the summer of 1917, in Clay County, Kansas, and after being carefully prepared so that not more than one grain would be in a "husk," was planted in the autumn on shallow benches in the

botanical greenhouse. Later, single individuals were transferred to pots, great care being taken to see that each plant in a pot represented a single seedling. The pots were placed in a bed in the greenhouse some distance apart and the plants made a good growth during the summer and autumn of 1918. They put out abundant stolons and began to bloom early in the spring of 1919. While the plants were in the greenhouse, five of them bloomed and all were pure in sexual expression. There were three pure carpellate plants and two pure staminate plants. On May 28, 1919, these five plants, together with eleven others in pots, were transplanted out of doors. These plants made a remarkable growth and all of them bloomed before the end of the summer. Of the eleven plants which bloomed out of doors, five were carpellate and six staminate. There were, therefore, exactly eight carpellate plants and eight staminate plants. None showed any signs of moneciousness. Two other plants in pots were kept in the greenhouse but have not bloomed up to the present time. The evidence from these sixteen plants, each grown from a single seed, is conclusive that *Bulbilis dactyloides* is strictly a diecious plant, and if intermediates, or monecious individuals, ever occur, either through the influence of environment or by a mutation, they are to be looked upon in the same light as other intermediates which occur in many normally diecious species.

The writer has no evidence whatever that a monecious form exists, but if there are specimens that show staminate and carpellate inflorescences on the same stolon or that show staminate and carpellate stolons coming without question from the same individual, the fact of a monecious form can be readily determined. The writer has shown elsewhere\* that maleness or femaleness, as expressed in the sporophyte of the Anthophyta, is frequently reversed, and such a reversal is, of course, theoretically possible in the buffalo-grass. If Hitchcock's plant was monecious, it may have been such an accidental intermediate. It is possible, however, that two seedlings may have been mistaken for one

\* Schaffner, John H. The expression of sexual dimorphism in heterosporous sporophytes. *Ohio Jour. Sci.* **18**: 101-125. 1918.

— The nature of the diecious condition in *Morus alba* and *Salix amygdaloides*. *Ohio Jour. Sci.* **19**: 409-416. 1919.

— Complete reversal of sex in hemp. *Science* **II**. **50**: 311-312. 1919.

unless especial care was taken to separate the individual grains from the hardened glumes. Because of the rapidity of growth and the great length of the stolons one can also readily make mistakes as to the limits or origin of individuals in the field. There is nothing in Plank's account which is entirely conclusive as to the nature of the plants he observed. The very fact that it is stated that each stolon produces its own kind would in itself throw doubt on the supposition that the plants observed were monocious. Plank made the statement, "there are probably a thousand individuals of the staminate form to one of the pistillate." This is not true of the seedlings, which according to my experiments and observations are about equally divided into staminate and carpellate individuals. In the field the one kind of inflorescence is about as abundant as the other. By superficial observation one might, however, get the notion that the staminate inflorescences were greatly in the majority, since the staminate stalks are comparatively tall and conspicuous while the carpellate are short and usually hidden among the leaf blades. In walking over a large patch of the grass, one might see very few carpellate inflorescences unless he got down on his hands and knees, especially if the grass had not been pastured. The buffalo-grass is holding its own well under civilized conditions and toward its eastern limit is spreading in the pastures and abandoned fields because its strongest competitors, *Andropogon scoparius* and *A. furcatus*, are much more subject to destruction through grazing and tramping of live stock.